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Hydromechanical Driving Device

The invention relates to a hydromechanical driving device of a strip-filter mechanism for generation of feed movements of the strip-like filter material of the strip-filter mechanism as a function of the pressure prevailing in the fluid to be filtered.

Strip-filter mechanisms in which a strip-like filter material is used as separating medium are known; see DE 43 11 297 A1 or DE 93 01 154 U1. In the operation of such mechanisms the filter material is advanced as a function of the extent of fouling of the respective strip area through which the filter material flows so as to make fresh filter material available for the filtration process as required. Since the differential pressure between the fouled side and the clean side of the strip-filter mechanism grows with increase in the extent of fouling of the filter material, the value of this differential pressure or the level of the pressure prevailing in the space containing the fluid to be filtered may serve as a criterion for initiation of a filter material feed movement.

The advance of the strip-like filter material may be effected by conventional means by winding the filter material. As is shown, for example, in German Patent Application 101 26 443.7, not of the state of the art, a fouled strip from a roll containing the supply of filter material is subsequently rolled onto a roll connected to the drive shaft of the drive device. In such strip-filter mechanisms the fluid to be filtered flows from the exterior inward through the unused filter

material, so that fouling of the filter material always occurs during the filtration process on the outermost layers of the roll which are wound from the feed roll when the degree of fouling is sufficiently great and onto the roll connected to the drive shaft of the drive device.

The electromotive drive devices usually provided for generation of the feed movement by rotation of the corresponding winding shaft result in relatively high structural complexity and correspondingly high costs.

The object of the invention is to provide a remedy in this connection by making available a drive device which is characterized by an especially simple design and correspondingly low production costs.

It is claimed for the invention that this object is attained by a hydromechanical drive device used to generate feed movements of the strip-like material for operation of strip-filter mechanisms as a function of the pressure prevailing in the fluid to be filtered, a drive which has

- a hydraulic accumulator with a movable separating element separating a first and a second accumulator space, which movable separating element to which may be applied on its side adjoining the accumulator space the pressure of the fluid to be filtered prevailing in this space,

- a mechanism converting movement of the separating element to feed movement, and

- a pressure control mechanism performing the function of generating in the second accumulator space a lower pressure effecting movement of the separating element as a function of the pressure level and/or the extent of fouling of the fluid to be filtered.

In that, as claimed for the invention, a hydromechanical drive is provided to replace the electromotive drive systems provided in the state of the art, significant simplification is obtained, since neither an external power supply nor a corresponding electronic control unit is required. In the case of the invention, the pressure of the fluid to be filtered functions, because of the movement of the separating element of the hydraulic accumulator it effects, both as energy source for the drive and as actuating variable determining initiation of the feed movement, since fouling of the section of the strip participating in the filtration process results in corresponding increase in pressure in the space of the strip-filter mechanism containing the fouled fluid to be filtered. The process in question is self-regulating, so that conversion of pressure to an electric signal may be dispensed with.

In one preferred exemplary embodiment the pressure control mechanism, which generates in one of the accumulator spaces of the hydraulic accumulator a pressure which is lower than the pressure of the fluid to be filtered, so that a movement of the separating element of the hydraulic accumulator and accordingly movement feeding the filter material are generated, may have a control valve which may be actuated by the movement of the separating element.

The configuration devised may be such that two fluid connections to the respective accumulator space are provided, connections by way of the first of which to this accumulator space pressure lower than that prevailing in the first hydraulic accumulator may be generated, while pressure equaling that prevailing in the first accumulator space is generated by way of the second fluid connection, since it is connected to the fluid to be filtered.

In this configuration the control valve is designed so that it is actuated by the movement of the separating element so that the first fluid connection is opened when the separating element is in one end position and the second fluid connection is closed and when the separating element

is in the other end position the second fluid connection is opened and the first fluid connection is closed.

In order to generate by way of the first fluid connection pressure in the second accumulator space which is lower than that of the fluid to be filtered, a pressure control valve may be provided at this connection, a pressure control valve which may be set for a pressure value which is lower than the pressure of the fluid to be filtered prevailing at the second fluid connection. As an alternative, this fluid connection may also be connected to the space of the strip-filter mechanism containing the filtered fluid, which space has a pressure lower than that of the fluid to be filtered.

The drive device may be integrated with the respective strip-filter mechanism on the basis of the hydrodynamic principle of operation of the drive device claimed for the invention, in which no external energy supply or external control is required. For example, the drive device is installed in its entirety in the respective strip-filter mechanism so that the hydraulic accumulator is positioned in or on the space containing the fluid to be filtered, which fluid may enter the first accumulator space of the hydraulic accumulator through suitable passages. By preference a diaphragm accumulator is used as the hydraulic accumulator. The mechanism for generation of the feed movement on the basis of the reciprocating movement of the separating element, for example, the diaphragm of the diaphragm accumulator, may have an actuating rod which moves back and forth and is connected to the separating element, as a component of a ratchet drive which converts the reciprocating movement to rotary movement in one direction of rotation (take-up direction) by means of a ratchet wheel and a detent operating in conjunction with this wheel in order to rotate the winding shaft so as to take up the roll with the fouled filter material. Another ratchet drive such as a free-wheel drive (not shown) might also be used in place of the ratchet wheel.

The invention will be described in greater detail below with the aid of an exemplary embodiment illustrated in the drawings in which:

- FIG. 1 shows a greatly simplified diagram of an axial section only of the diaphragm accumulator of the exemplary embodiment of the drive device claimed for the invention;

- FIG. 2 shows a diagram of operation of the exemplary embodiment of the drive device claimed for the invention; and

- FIG. 3 shows a diagram of operation in the form of a top view of the part of a strip-filter mechanism in which are mounted a feed roll of filter material in strip form and a roll for take-up of used filter material to be wound by means of the drive device claimed for the invention.

FIG. 3 shows a greatly simplified diagram of a space 3 inside a housing 1, this space containing a fouled fluid to be filtered. A feed roll 5 with strip-like filter material is mounted so as to rotate freely on a fluid-permeable core 7 in the space 3. The space 9 situated inside the core 7 receives the filtered fluid which flows through the roll 5 from the exterior to the interior, that is, from the space 3, the filtration process being effected by filtration in depth and the fouling particles filtered out being deposited on the outermost layers of the feed roll 5.

The increase in the differential pressure between the space 3 containing the fluid to be filtered and the space 9 containing the filtered fluid resulting from the increase in the extent of fouling of the outer layers of the feed roll 5 performs the function of actuating variable for initiation of a process of feeding the strip-like filter material, in which process this material is

wound off the feed roll 5 and onto a take-up roll 11. The directions of rotation of feed roll 5 and take-up roll 11 occurring during this feed process are indicated by curved arrows. The take-up roll 11 is set in rotation by a winding shaft 13 (also see FIG. 2) of the drive device claimed for the invention.

FIG. 2 shows a simplified diagram of the ratchet drive designated as a whole as 15 which generates the rotary movement of the winding shaft 13 on the basis of the reciprocating movements of an actuating rod 17. The reciprocating movements of the rod 17 in the direction of the double arrow 19 result in reciprocating pivoting about the winding shaft 13 of a freely pivoting ratchet lever 21 to which a spring-loaded ratchet 25 is hinge-connected for engagement with the sawtooth gearing 27 of a ratchet wheel 23. This ratchet 25 interacts with the sawtooth gearing 27 so that rotary movement of the ratchet wheel 23 counterclockwise occurs only when the actuating rod 17 moves to the left (in FIG. 2).

The mechanism for generating the reciprocating movement of the rod 17 is illustrated in detail in FIG. 1. This mechanism has a hydraulic accumulator in the form of a diaphragm accumulator 29, the diaphragm 31 of which forms a movable separating element between a first accumulator space 33 and a second accumulator space 35. A pressure plate 37 which is applied to the diaphragm 31 on the side of the latter facing the accumulator space 35 is rigidly connected to the actuating rod 17, which is centrally positioned and extends in the longitudinal direction of the housing of the diaphragm accumulator 29 and which may be moved back and forth in this longitudinal direction (double arrow 19) as the diaphragm 31 is moved. The cover 39 on the end side and positioned on the accumulator space 33 not only forms a guide for the actuating rod 17 but also has ports 41 by way of which the accumulator space 33 is connected to the space 3 containing the fluid to be filtered (see FIG. 3) of the strip-filter mechanism so that the pressure of the fluid to be filtered prevails in the accumulator space 33 during operation. A pressure spring 45 is supported by the cover 39 and a stop plate 43 of the actuating rod 17 so that the diaphragm

31 and actuating rod 17 are pretensioned for movement to the right as shown in the drawing into an end position illustrated in FIG. 1.

The space 35 positioned on the left in FIG. 1 is closed up to a first fluid connection 47 and a second fluid connection 49. A control valve situated in the space 35 has a movable valve body 51. The valve body 51, which is indicated only in highly simplified diagrammatic form in FIG. 1, forms part of a seat valve by which one of the fluid connections 47, 49 may be opened while the other connection 47, 49 may be closed, depending on the position of the valve body 51. The valve body 51 may be controlled by the movement of the diaphragm 31. When the diaphragm 31 is situated in the end position, shown in FIG. 1 to be on the right side, the valve body 51 is in a position in which the first fluid connection 47 is open and the second fluid position 49 is closed. The valve body 51 is actuated by way of an above-center tilting mechanism, connecting this element 51 to the diaphragm 31 so that the valve body 51 is switched more or less instantly only in the two end positions of the diaphragm 31. This tilting mechanism has an actuating rod 55 which is hinge-connected to the valve body 51 in a sleeve 53 and is guided in movement against the force of a spring. The sleeve is hinge-connected by way of a forked connecting rod 57 to the facing end 59 of the actuating rod 17. A roll 61 which is unrolled on the inside of the diaphragm accumulator housing is positioned at the free end of the sleeve 53.

When the diaphragm 31 moves to the left from the end position shown in FIG. 1, the sleeve 53 is moved, the roll 61 being unwound on the inner wall of the accumulator in the direction of an arrow 63, the rod 55 entering the sleeve 53 a short distance against the force of the spring. When the above-center position of the sleeve 53 is reached, such being the case when the left-side end position of the diaphragm 31 is reached, the rod 55, under the force of the spring, reverses the valve body 51 about the fulcrum of the latter, designated as 65, in a tilting

movement indicated by a broken-line arrow 67 into the other valve position, so that the fluid connection 49 is instantly opened and the fluid connection 47 is instantly closed.

The method of operation of the drive device is as follows: the pressure of the fluid to be filtered prevails in the accumulator space 33 in the position illustrated in FIG. 1. The pressure prevailing in the other accumulator space 35 is set at a correspondingly lower pressure by means of the pressure control valve 69 mounted on the fluid connection 47. If, during the operation of the strip-filter mechanism, the pressure of the fluid to be filtered and so the pressure in the accumulator space 33 increases as a result of increase in the extent of fouling of the filter material to a value at which the action of the reset spring 45 tends to retain the diaphragm 31 in the end position on the right shown in FIG. 1 is overcome, the diaphragm 31 and accordingly the actuating rod 17 are moved to the left as shown in FIG. 1, the winding shaft 13 (see FIG. 2) being rotated by means of the ratchet drive 15 so that used filter material is wound off the feed roll 5 and onto the take-up roll 11 by the winding shaft 13.

When the end position of the diaphragm 31 on the left-side end is reached (this position is not illustrated), the tilting mechanism instantly reverses the valve body, so that the fluid connection 49 is opened and the fluid connection 47 closed as a result of the pivoting indicated by the arrow 67 (FIG. 1). The fluid connection 49 is connected to the fluid to be filtered (space 3 in FIG. 3), so that the same pressure now prevails in the accumulator space 35 as in the accumulator space 33, as a result of which the diaphragm 31 is moved by the force of the reset of the spring 45 back to the right into the end position shown in FIG. 1, the tilting mechanism moving the valve body 51 in turn into the valve position illustrated in FIG. 1, so that the initial state is again reached, that is, the operating cycle is completed.

In place of the connection of an adjustable pressure control valve to the fluid connection 47, the fluid connection 47 could be connected directly to the space 9 (FIG. 3) containing the

filtered fluid, in which the pressure level is lower than that in the space 3. When a pressure control valve 69 is used, the resulting controlled amount is discharged into the tank (not shown) upstream from the strip-filter mechanism.

FIGS. 2 and 3 show that the entire drive device is installed in the housing 1 of an appropriate strip-filter mechanism. As is to be seen in FIG. 3, as the operation progresses in which filter material is in succession wound off the feed roll 5 and onto the take-up roll 11, the latter becomes greater in diameter while the diameter of the feed roll 5 is smaller. As FIGS. 2 and 3 show, in keeping with this circumstance, the winding shaft 13 and the take-up roll 11 are mounted on a pivoted rocker 71. As FIG. 2 shows, all components of the drive device are mounted on this rocker 71, that is, both the diaphragm accumulator 29 with the actuating rod 17 and the ratchet drive 15 for the winding shaft 13, which may be actuated by this rod. Consequently, as the diameter of the take-up roll 11 increases, the entire drive device may be moved by the rocker 71 to adjust to the diameter of the roll, so that the axis of rotation of the winding shaft 13 may be displaced, as is illustrated by broken lines in FIG. 3.

The diaphragm accumulator 29 provided in the exemplary embodiment may be replaced by a hydraulic accumulator of another type with movable separating element in order to actuate the actuating rod 17 of the drive device in reciprocating movement. The hydraulic accumulator in question is not to be understood in the classic sense as performing the function of storing hydraulic energy but is rather to be viewed more as a medium separating element, one separating element 31 separating two media accumulator spaces 33, 35.

The differential pressure measured could also be represented by the dynamic pressure, which increases with increase in the extent of fouling. In this instance the accumulator space 35 preferably is connected to the tank by way of the valve 69. The amount of the differential pressure or of the dynamic pressure may be adjusted by way of the force of the spring of the

respective valve 69. In addition, the tilting mechanism 53, 55 performs a safety function in that it initiates a discharge process, for example, when the pressure peaks in the respective accumulator space are impermissibly high. Since the fluid connection 49 of the accumulator space 35 may be connected to the fouled side of the device, a suitable filter device (not shown) may be provided upstream from the connection 49.